were found to be almost identical, the most marked of the few differences being that the blood-red colour given with nitric acid is much more permanent than in the similar apomorphia reaction. Between the two bases also a very marked difference exists in respect of stability, apocodeia being far superior in this respect to apomorphia; in fact it may be precipitated by ammonia or carbonate of sodium, washed and dried, without undergoing a marked change of colour.

The hydrochlorates also differ; for that of apomorphia can be easily crystallized, whereas hydrochlorate of apocodeia has only been obtained in an amorphous state. The preparation of apocodeia is easy and sure, yielding a very large product. In this respect it differs materially from apomorphia, the preparation of which is tedious, and the amount of yield very uncertain, hence the high price of this valuable therapeutical agent. The solutions of the two hydrochlorates also show the same differences that the bases themselves do. In physiological effects also there is a decided difference between the hydrochlorates, that of apomorphia being, as observed by Dr. Gee, a very violent emetic, whilst that of apocodeia is, according to Dr. Legg's experiments, a mild emetic; it also produces subcutaneous abscesses at the place of injection, which the apomorphia salt does not.

It has been shown in Part II. (Proc. Roy. Soc. vol. xvii. p. 460) of these researches, that when codeia is heated with hydrochloric acid it splits up into chloride of methyl, water, and apomorphia. The action of hydriodic acid on narcotine for the elimination of the methyl contained in it is, however, more energetic than that of hydrochloric acid. Therefore it was thought probable that, by means of hydriodic acid, CH_3 might be abstracted alone, as iodide of methyl, from the codeia, leaving the elements of water, and thus forming morphia.

On trying the experiment, however, not a trace of iodide of methyl was obtained, but the iodide of a new base, which is at present under examination.

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The codeia with which the foregoing experiments were made was kindly presented to us by Messrs. M^c^Farlan and Co., of Edinburgh, to whose liberality we are already so much indebted.

"Experiments on the Action of Red Bordeaux Wine (Claret) on the Human Body." By E. A. Parkes, M.D., F.R.S., Professor of Hygiene in the Army Medical School, and Count Cyprian Wollowicz, M.D., Assistant Surgeon, Army Medical Staff. Received July 5, 1870.

In the Proceedings of the Royal Society (No. 120) is an account of some experiments with pure alcohol and brandy on a healthy man. This paper is intended as a continuation, with the substitution in the experiments of red Bordeaux wine (claret) for alcohol and brandy. The same

man was the subject of the experiments, and he was placed on precisely the same diet as is recorded in the former paper.

The experiments were continued for 30 days, the man having abstained from any alcoholic beverage for 16 days previously. During the first 10 days, water only was taken at dinner, during the next 10 days red Bordeaux wine was substituted for the water; 10 fluid ounces (284 cub. centims.) being given on the first 5 days, and 20 fluid ounces (568 cub. centims.) on the last 5 days. The wine was taken at dinner time, at a quarter past 1 o'clock. In the last 10 days water was again given.

The wine was a good claret, as it was thought best to use a superior wine; it was Haut Brion wine of second growth, of the vintage of 1863, and was sold in London at the price of 60*s.* per dozen. It contained 11 per cent. of alcohol. The free acidity was equal to about 3 grains per ounce of tartaric acid ($C_4 H_6 O_6$); the total solids amounted to 21·76 grammes, and the fire-proof salts to 2·359 grammes per litre. Of this amount of salts 2·027 grammes were soluble, and ·332 insoluble. In the former, phosphoric acid and chlorine were present in the amounts of ·145 and ·106 gramme per litre respectively; the insoluble salts contained only ·0175 gramme of phosphoric acid per litre. In the 10 ounces of wine there were therefore only 0·7 grain of phosphoric acid, and 0·46 grain of chlorine.

The ash was intensely alkaline, and, when neutralized with standard acid, the alkalinity was found to be equal to 1·679 gramme of tartaric acid ($C_4 H_6 O_6$) per litre.

Only two circumstances (except the taking of wine) were different in this set of experiments as compared with the former.

The first experiments were made in February and March 1870, when the weather was very cold; the present were made in May and June in very hot and dry weather. The only influence we could trace to this altered condition of climate was that the amount of water allowed was insufficient, and the man suffered some discomfort from thirst. We could not perceive that any effect was produced on the nitrogenous elimination; certainly there was no diminution.

The other alteration was that the man had gained 4 lbs. in weight, and was still gaining a little when the experiments were commenced; he continued to do so slowly until the 24th day, when his health began to give way and he lost weight.

The experiments included the number of the pulse (taken in the recumbent position) every 2 hours from 8 A.M. to 10 P.M., tracings of the pulse and respirations, the temperature of the axilla every 2 hours from 6 A.M. to 10 P.M., the temperature of the rectum four times a day (the observations being taken with the same thermometers as on the former occasion), the amounts of nitrogen, phosphoric acid, chlorine and free acidity of the urine, and the weight, and in the two cases the amount of nitrogen in the stools.

1. Weight of the Body

(*taken at 8 a.m. before breakfast and after emptying the bladder*).

Days.	Weight, in lbs.	Weight, in kilogrammes.	Days.	Weight, in lbs.	Weight, in kilogrammes.	Days.	Weight, in lbs.	Weight, in kilogrammes.
1.	140	63·6	11.	140·5	63·86	21.	140·5	63·86
2.	140	63·6	12.	140·5	63·86	22.	140·6	63·91
3.	140	63·6	13.	140·6	63·91	23.	140·6	63·91
4.	140	63·6	14.	140·6	63·91	24.	140·6	63·91
5.	140	63·6	15.	140·6	63·91	25.	140·5	63·86
6.	140·5	63·86	16.	140·6	63·91	26.	140·4	63·81
7.	140·5	63·86	17.	140·6	63·91	27.	140·3	63·77
8.	140·5	63·86	18.	140·6	63·91	28.	140	63 6
9.	140·5	63·86	19.	140·5	63·86	29.	140	63·6
10.	140·5	63·86	20.	140·5	63·86	30.	140	63·6
Means	140·25	63·75		140·55	63·863		140·35	63·79

Owing to the rather larger supply of food and the lessened exercise the weight increased slightly, but remained, on the whole, in tolerable equilibrium until the 24th day, when he became indisposed, and lost weight regularly every day for 4 days. No obvious change in weight was caused by the wine.

2. The Circulation.

Pulse before wine (*taken in the recumbent position.*)

Days.	Hours.								Mean of the days.
	8 A.M.	10 A.M.	12 noon.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	
1st day ...	74	86	74	84	77	84	72	72	77·87
2nd day ...	67	72	72	82	77	80	75	70	74·37
3rd day ...	71	80	72	82	76	82	85	72	77·5
4th day ...	65	75	80	89	73	73	78	67	75
5th day ...	76	82	72	84	81	82	73	73	77·87
6th day ...	76	74	77	87	73	76	72	78	76·0
7th day ...	72	78	70	90	74	75	90	69	77·2
8th day ...	76	79	73	83	78	84	70	72	76·87
9th day ...	67	78	75	77	75	76	73	73	74·2
10th day...	73	80	77	79	74	76	78	67	75·5
Mean	71·7	78·4	74·2	83·7	75·8	78·8	76·6	71·3	76·3

The pulse in this man had a daily course of great uniformity, the changes being chiefly dependent on food and in a less degree on exercise. If the last line (the mean of the hours) is read, and it is remembered that breakfast was taken at 8, dinner at 1, and tea at 5, the increase in the number of beats at 10, 2, and 6 o'clock is at once accounted for. It rose after breakfast nearly 7 beats; then fell 4 beats; rose after dinner nearly 10 beats; then fell, but not to its previous standard; rose after tea 3 beats, and then fell, till at 10 P.M. it was nearly the same as at 8 A.M. The

other cause influencing the heart's beats was exercise; we kept the exercise as uniform as we could, but there were variations, and we could often trace defect or excess of exercise on the next reading of the pulse. The daily mean of the pulse was fairly uniform, the mean of the 10 days being 76·3 beats per minute, the extreme mean daily variation was from 74·2 to 77·87.

Pulse during wine; 10 *ounces at* 1 *o'clock during the first* 5 *days, and* 20 *ounces during the last* 5.

Days.	Hours.								Mean of the days.
	8 A.M.	10 A.M.	12 noon.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M	
11th day...	67	79	76	79	80	87	80	72	77·5
12th day...	72	71	72	85	82	90	95	82	81·1
13th day...	76	73	70	86	84	89	80	73	78·8
14th day...	67	82	83	92	87	89	76	78	81·7
15th day...	70	81	77	92	88	93	84	76	82·6
16th day...	77	80	75	76	94	86	87	76	81·3
17th day...	74	82	75	93	88	86	80	74	81·5
18th day...	76	75	75	94	88	91	78	69	80·7
19th day...	76	82	69	86	96	89	82	78	82·2
20th day...	68	86	67	85	89	81	79	71	78·2
Means.....	72·3	79·1	73·9	86·8	87·6	88·1	82·1	74·9	80 5

The wine increased the frequency of the heart's action by 4¼ beats every minute during 14 hours in the day, and doubtless also in the remaining 10, for the pulse at 8 A.M. was still too frequent during the wine period. In the 24 hours there was then an excess in the heart's action of 6120 beats, or nearly 6 per cent. As the amount of alcohol was 1·1 ounces in the first 5 days, and 2·2 ounces in the other 5, the increase in the number of the heart's beats was slightly more than in the days when an equal quantity of pure alcohol was taken.

This was partly owing to the continuance of the wine, as the first day's excess was only 1658 beats, and partly to the fact that whereas in the former series of experiments the mean pulse-beats in the water period were 73·, in this they were 76·3. The man's heart was evidently rather more excitable in this series than in the former.

When the hourly changes are compared with the water period, it is seen that the influence of food is marked as before, but that the wine exaggerated the effect, and kept the pulse at a greater rate for a longer time.

An extract from the Tables will show this. It must be noted that the wine was taken at 1 o'clock, or a little after.

	Water period.	Wine period.
Mean number of pulse at 10 A.M. after breakfast..	78·4	79·1
Mean at 2 P.M. after dinner	83·7	86·8
Mean at 4 P.M.....	75·8	87·6
Mean at 6 P.M. after tea	78·8	88·1
Mean at 8 P.M.....	76·6	82·1
Mean at 10 P.M.	71·3	74·9

It will be seen, then, that the pulse at 4, 6, and 8 o'clock in the wine period is much above the corresponding numbers in the water period. The effect of the wine is largely perceptible for eight hours, and is traceable during all the observations. The mean of the first five days is 80·34 beats per minute, and of the last five days 80·78 beats.

The effect of increasing the wine to 20 ounces is chiefly perceived in the greater acceleration of the pulse at 4 o'clock in the last five days as compared with the first five. When 10 ounces were taken, the mean pulse at 4 o'clock was 84·2, or two beats per minute less than at 2 o'clock, whereas in the 20-ounce days the mean pulse at 4 o'clock was four beats above the 2 o'clock rate.

Pulse after wine.

Days.	Hours.								Mean of the days.
	8 A.M.	10 A.M.	12 noon.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	
21st day ...	68	86	74	96	84	90	70	69	79·6
22nd day...	78	84	72	80	78	83	81	69	78·1
23rd day...	72	80	74	84	84	78	81	72	78·1
24th day...	73	79	76	83	79	84	82	74	78·75
25th day...	70	77	73	77	74	82	81	78	76·5
26th day...	69	84	77	82	78	84	77	65	77
27th day...	70	75	95	99	89	92	92	80	84·5
28th day...	70	79	87	86	84	86	84	84	82·5
29th day...	74	82	74	84	84	80	83	79	80
30th day...	70	80	70	96	89	79	74	72	78·75
Means.....	71·4	80·6	77·2	86·7	82·3	83·8	80·5	74·2	79·38

The pulse continued high during the whole of this period, the excess being chiefly in the afternoon hours; even 10 days after the wine was left off it had not returned to its proper rate; but this was probably in part owing to indisposition, which will be referred to presently.

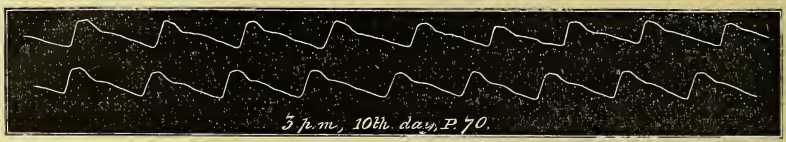
Sphygmographic observations were taken three times a day; but as the curves from alcohol were so fully given in the former paper, we have thought it necessary only to put in nine curves, three before, four during, and two after wine. We have selected 3 o'clock as the hour, so that the influence of food is perceptible in all: the effect of the wine was the same as that of alcohol, though of course in a degree proportional to the amount.

We also attempted to determine the ratio of the radial pulse, heart's action, and respiration by means of Dr. Burdon-Sanderson's ingenious cardiograph. Unfortunately we did not obtain the instrument in time to determine the curves properly in the period before wine, and we are therefore not able to give proper comparisons. We could not, however, so far trace any effect on the number or depth of the respirations.

Before claret.—At 3 P.M., 2 hours after dinner.

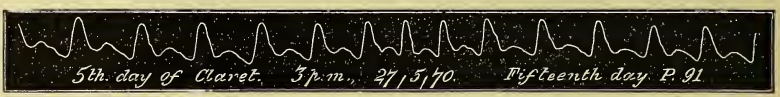






During claret.—2 hours after dinner.

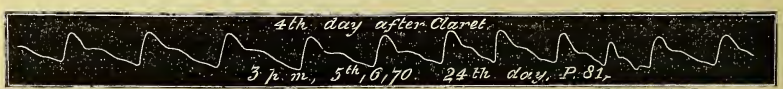


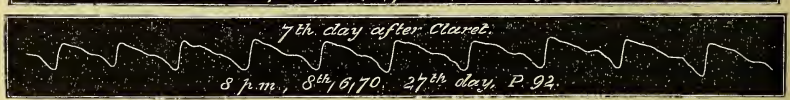






After claret.—2 hours after dinner.





3. The Temperature of the Body

The temperature was taken both in the axilla and rectum, in order to obtain a control of the observations. The degrees are Fahrenheit.

(*a*) In the Axilla.

The thermometer was kept in the axilla for 20 minutes or more, while the man was in bed and covered with the clothes.

First Period. Temperature of axilla before wine.

Days.	Hours.									Mean of the days.
	6 A.M.	8 A.M.	10 A.M.	12 noon.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	
1st day ...	97·8	98·0	98·0	98·0	98·4	98·4	98·4	98·2	98·4	98·17
2nd day ...	97·4	97·4	98·0	97·6	98·4	97·8	98·0	98·8	98·0	97·93
3rd day ...	97·8	97·0	97·4	97·4	98·2	98·0	97·2	98·6	98·4	97·77
4th day ...	97·2	97·0	98·4	97·3	97·4	97·4	97·8	98·0	97·6	97·56
5th day ...	97·8	97·4	97·2	97·0	97·6	97·6	98·0	98·0	97·6	97·57
6th day ...	97·6	97·4	97·6	97·8	97·6	97·8	97·6	97·6	97·2	97·57
7th day ...	97·6	97·8	97·4	97·0	98·0	97·6	97·8	97·6	97·4	97·57
8th day ...	97·8	97·6	97·2	97·8	97·8	97·4	97·6	98·0	97·4	97·62
9th day ...	97·4	97·2	98·2	97·6	98·2	97·6	98·0	97·4	98·0	97·73
10th day...	97·0	97·4	98·0	98·0	98·2	97·4	97·8	98·8	97·4	97·77
Means.....	97·54	97·42	97·74	97·55	97·98	97·70	97·82	98·10	97·74	97·726

It will be seen on reading the last line (mean of the hours) that the temperature follows the same course as the pulse in being manifestly influenced by food, and rising after breakfast, dinner, and tea. The only exception (and this is perhaps apparent only) is at 8 P.M., when the mean temperature is higher than at 6 P.M. while the pulse is falling; but this was perhaps accidental, *i. e.* a longer series of observations might have given different results; for in three observations the temperature was higher at 6 o'clock, and in three it was equal, while in the other four, when it was highest at 8 o'clock, there were two exceptional high temperatures which augmented the mean amount. In the next period the mean temperature at 8 P.M. was lower than at 6.

We were unable to see any diurnal change of temperature in this man apart from food; there was no afternoon or evening rise of temperature, dependent solely on the time of day.

The temperature was more uniform than in the experiments in February,

Second Period. Temperature of axilla during wine.

Days.	Hours.									Mean of the days.
	6 A.M.	8 A.M.	10 A.M.	12 noon.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	
11th day...	97·0	97·2	97·6	97·8	98·0	97 6	97·6	97·8	97·4	97·55
12th day...	97·2	97·4	97·0	97·4	97·0	97·2	98·0	97·6	97·4	97·35
13th day...	97·0	97·2	97·6	97·6	98·0	97·4	98·2	97·4	97·0	97·48
14th day...	96·8	97·0	97·8	97·2	98·0	97·8	98·4	98·0	97·6	97·4
15th day...	97·4	97·6	98·0	97·4	98·2	98·2	98·0	98·2	97·8	97·85
16th day...	97·4	97·8	97·4	98·0	97·8	98·0	98·0	97·6	97·6	97·73
17th day...	96·8	97·0	97·4	97·4	98·0	97·8	97·4	97·0	97·0	97·31
18th day...	97·2	97·2	97·6	98·0	97·8	97·6	97·4	not	taken	97·54
19th day...	97·6	98·0	97·4	97·4	98·2	97·8	98·0	97·8	98·0	97·8
20th day...	96·8	97·0	98·0	97·8	98·0	97·4	97·8	97·6	97·8	97·59
Means.....	97·12	97·3	97·58	97·60	97·90	97·68	97·88	97·66	97·50	97·56

If the mean temperature at 2, 4, 6, and 8 o'clock, when the wine was acting most on the pulse, are placed side by side, we have,—

Hours.	Temperature.	
	Water period.	Wine period.
2 P.M.	97·98	97·90
4 P.M.	97·70	97·68
6 P.M.	97·82	97·88
8 P.M.	98·10	97·66

The temperatures of the three first hours are practically identical, and as already said, the rise at 8 o'clock in the water period seems to us accidental, *i. e.* as dependent on two exceptional high temperatures, which raised the mean amount. In the other 5 hours the mean temperature was four times slightly higher in the water, and once in the wine period.

The result of all the observations was that, in the water period of ten days, the mean temperature was 97°·726, and in the wine period was 97°·56, or 0°·166 less, a difference so slight as probably to fall within the limits of unavoidable error. The mean of the first five days, with 10 ounces of wine, was 97°·526; the mean of the last five days, with 20 ounces of wine, was 97°·590, proving that doubling the amount of wine caused no lowering of mean temperature, and probably no rise, as the difference is so slight.

We conclude that in health the apparent heat after wine must be owing, as in the case of alcohol and brandy, rather to subjective feelings connected with the quickened circulation than with an actual rise of temperature; but that, on the other hand, wine in the above quantities causes no appreciable lowering of temperature.

Third Period. Temperature of Axilla after wine.

Days.	Hours.									Mean of the days.
	6 A.M.	8 A.M.	10 A.M.	12 noon.	2 P.M.	4 P.M.	6 P.M.	8 P.M.	10 P.M.	
21st day...	97·2	97·4	98·0	98·3	99·2	98·4	98·6	97·6	97·6	98
22nd day..	97·4	97·4	98·2	97·8	98·2	97·8	98·0	97·4	97·0	97·6
23rd day...	97·6	97·6	98·0	98·0	98·4	98·0	97·8	98·0	98·2	97·9
24th day...	97·2	97·4	97·6	97·6	98·2	97·6	98·0	97·6	97·0	97·5
25th day...	97·8	98·0	97·8	98·4	99·2	98·0	98·2	97·6	97·2	98·0
26th day...	97·0	97·0	98·2	98·4	98·8	97·6	97·8	97·8	97·4	97·7
27th day...	97·0	96·8	97·8	98·4	99·8	98·6	98·0	97·6	97·0	97·8
28th day...	97·0	97·0	97·4	98·0	98·6	98·2	98·0	97·8	97·6	97·7
29th day...	97·2	97·0	97·6	97·6	98·0	97·6	98·0	98·4	98·2	97·7
30th day...	97·4	97·6	98·0	97·4	98·2	97·8	98·0	97·8	97·6	97·8
Means.....	97·28	97·32	86	97·99	98·66	97·96	98·04	97·76	97·48	97·86

In this period the diurnal variations were almost identical with the others, and the mean temperature of the whole period was practically the same as that of the first ten days.

(*b*) In the Rectum.

Rectum before wine (*thermometer inserted for about 3 inches, and kept in for 20 minutes*).

Days.	Hours.				Mean of the days.
	8 A.M.	12 noon.	4 P.M.	10 P.M.	
1st day ...	99	99·6	99·95	99·8	99·27
2nd day ...	99·2	99·2	99·4	99·2	99·25
3rd day ...	99·8	99	99·2	99·5	99·37
4th day ...	99·8	99·4	99·4	99·6	99·55
5th day ...	99·4	99·6	99·2	99	99·3
6th day ...	99·2	99·8	99·6	99·6	99·55
7th day ...	99·6	99·6	99·2	99·4	99·45
8th day ...	99·4	99·6	99·4	99·2	99·4
9th day ...	99	99·4	98·6	99·0	99
10th day...	98·6	99·8	99·4	99·8	99·65
Means ...	99·2	99·50	99·29	99·41	99·38

The mean temperature of the rectum (taken four times a day instead of three, as in the former experiments, and at different hours) was rather higher than the mean of the former experiments, viz. as 99·38 to 99·066. It was also more uniform, both from day to day and hour to hour. If these four hours be accepted as giving the mean temperature of the 24 hours, the rectum temperature was 1°·654 above that in the axilla.

Rectum during wine.

Days.	Hours.				Mean of the days.
	8 A.M.	12 noon.	4 P.M.	10 P.M.	
11th day...	98·6	99·9	99·2	99·6	99·37
12th day...	98·4	99·4	99·6	99·2	99·15
13th day...	98·6	99·4	99·8	99	99·2
14th day...	98·8	99·8	99·2	99	99·2
15th day...	99·4	99·6	99	99	99·25
16th day...	99·8	99·4	99·6	99·4	99·55
17th day...	98·6	99·6	99·8	99	99·25
18th day...	98·8	99·6	99·2	98	98·9
19th day...	98·6	99·5	99	98·4	98·87
20th day...	99	99·8	99·4	99·8	99·5
Means ...	98·86	99·60	99·38	99·04	99 22

The mean temperature is 0°·16 lower. It is curious that this is almost precisely the same change as in the case of the axillary temperature; yet it is probably an accidental coincidence. The 4 P.M. temperature, which ought to show the effect of wine, is slightly higher (0°·09) than in the first period; the 10 P.M. and 8 A.M. temperatures are lower by nearly 0°·3, and the 12 o'clock temperature is higher by 0°·1.

The differences are thus slight, and in contrary directions, so that no decided influence, one way or the other, can, we think, be ascribed to the wine.

Rectum after wine.

Days.	Hours.				Mean of the days.
	8 A.M.	12 noon.	4 P.M.	10 P.M.	
21st day ...	99·8	99·9	99·4	99·2	99 57
22nd day ..	99·0	99·6	99·8	99·0	99·35
23rd day...	99·0	99·5	99·2	99·6	99·32
24th day...	99·2	99·4	99·2	99·0	99·2
25th day...	99·6	99·4	99·4	99·2	99·4
26th day...	98·8	99·2	99·4	99·0	99·1
27th day...	98·8	99·2	99·2	99·4	99·15
28th day...	99·0	99·4	99·6	99·4	99·35
29th day...	99·6	99·2	99·0	99·6	99·35
30th day...	98·8	99·8	99·6	99·4	99·4
Means.....	99·16	99·46	99·38	99·28	99·32

The temperatures are almost precisely the same as in the first period. The 4 o'clock temperature is identical with that of the wine-period.

4. Action on the Urine.

Elimination of water by the kidneys.

Twenty-eight fluid ounces were taken as drink, and the water in the so-called solid food made the total daily ingress of water 72½ fluid ounces, or 2059 cub. centims.

The following are the means of the three periods:—

	Amount of water taken daily in solid food and as drink.	Mean amount of urine passed in 24 hours.
1st period (water)	2059 c.c.	1210 c.c.
2nd period (wine)	2010 c.c.	1148 c.c.
3rd period (water).....	2059 c.c.	1155 c.c.

As 49 cub. centims. less water were taken in the wine-period, the amount of urine ought perhaps to be increased by this amount, and this would make it only 13 cub. centims. less than the first period.

It may be concluded that 10 and 20 ounces of light wine (containing 1·1 and 2·2 ounces of alcohol), when substituted for water, had no diuretic effect. The amount of alcohol to act as a diuretic was perhaps too small, as in the former series with the larger quantities of alcohol there was certainly some increased flow of urinary water.

Elimination of nitrogen by the kidneys.

The same amount of food being given as in the previous experiments, the amount of nitrogen passing into the body was 17¼ or 17½ grammes, or probably a little more. The whole of this passed by the urine and bowels, so that in this respect the difference in the temperature of the air had no effect. In other words, although the weather was so hot, there was no evidence of urea escaping by the skin.

The substances precipitated by Liebig's mercuric nitrate were as usual termed urea, and the nitrogen was calculated from this. It was also for the sake of control determined by soda-lime.

Nitrogen before claret.

Days.	Urea.	Nitrogen calculated from urea.	Nitrogen by soda-lime.
	grammes.	grammes.	grammes.
1st day	30·299	14·139	14·211
2nd day	33·343	15·560	16·555
3rd day	31·094	14·487	14·917
4th day	34·960	16·315	16·933
5th day	31·038	14·484	15·323
6th day	40·200	18·760	18·639
7th day	37·800	16·640	17·469
8th day	39·633	18·495	18·024
9th day	37·050	17·290	16·779
10th day.....	39·940	18·635	
Means	35·535	16·680	16·539

The mean of the nine days of ureal nitrogen, which correspond with the days of soda-lime nitrogen, is 16·493 grammes. The mean of the ten first days in the previous series, with an equal quantity of food, was 16·211 grammes of nitrogen as calculated from the urea, and 16·226 grammes as determined by soda-lime. In the present experiments the amounts are higher in a very trifling degree, viz. ·379 gramme, and ·313 gramme in excess respectively. The difference is so slight (under 6 grains in 24 hours) that the two series may be considered identical. Possibly as the man was 4 lbs. heavier, there might be some additional nitrogenous tissue furnishing the slight excess of nitrogen.

Nitrogen during claret.

Days.	Urea.	Nitrogen calculated from urea.	Nitrogen by soda-lime.
	grammes.	grammes.	grammes.
11th day.....	37·137	17·331	
12th day.....	35·325	16·485	16·839
13th day.....	38·356	17·899	18·825
14th day.....	34·860	16·268	16·074
15th day.....	35·040	16·352	17·255
16th day.....	37·570	17·532	16·707
17th day.....	41·745	19·486	18·886
18th day.....	35·048	16·355	15·764
19th day.....	34·650	16·170	15·443
20th day.....	31·510	14·701	14·600
Means	36·124	16·858	16·421

The variations from the period before claret are so slight, and indeed

insignificant, as to prove that 10 and 20 fluid ounces of claret, taken for two periods of five days, caused no alteration in the elimination of nitrogen, when the egress of nitrogen was constant.

Thus to express the result in grains, the daily nitrogen calculated from the urea was, in the first period of ten days, 257·37 grains, and in the second or wine-period 260 grains. In nine days of the two periods, the daily nitrogen by soda-lime was 255·19 grains in the water-, and 253·35 grains in the wine-period.

Nitrogen after claret.

Days.	Urea.	Nitrogen calculated from urea.	Nitrogen by soda-lime.
	grammes.	grammes.	grammes.
21st day	45·500	21·233	20·779
22nd day	42·900	20·020	
23rd day.....	38·112	17·780	18·159
24th day.....	36·960	17·448	17·640
25th day.....			14·119
26th day.....	42·900	20·020	
27th day.....	41·128	21·193	
28th day.....	44·646	20·805	20·110
29th day.....	38·739	18 078	18·548
30th day.....	27·777	12·938	13·324
Means	39·851	18·883	17·525

As one determination of urea and three determinations of nitrogen by soda-lime were lost, in order to find the daily amount of nitrogen in the whole of the ten days, the soda-lime nitrogen of the 25th day may be added to the total ureal nitrogen, and the mean taken. If this be done, the mean daily excretion of nitrogen was 18·362 grammes. This gives an excess of no less than 1·682 gramme over the first period, and 1·504 over the wine-period. The excess was so large, and was so unlike anything seen before during any of the experiments, as to prove it was not accidental.

The question now arises, if the increase was owing to the direct effect of the wine. This seems unlikely, partly because some evidence of increase would then have been obtained from the ten days during which the wine was taken, and partly from another reason. During this last period the man became ill; he was not feverish, but his pulse was quick. On the 25th, 26th, and 27th days there was some looseness of the bowels and headache; he could scarcely eat his food, and lost weight for the first time.

On the 29th day he was better, and on the 30th felt quite well, and on that day the nitrogen (as determined in both ways) fell greatly. He ascribed his illness to the monotony of his life, the sameness of his diet, and the comparative want of exercise, whilst it is also possible that the

wine, to which he was unaccustomed, and the small allowance of water, may have had some effect in deranging his nutrition. It seems, however, fair to conclude that the wine had only an indirect share, if any, in causing this illness and increased elimination, which was manifestly caused by some peculiar morbid state of nutrition. It is noticeable in this case that there was increased elimination of nitrogen (evidently in the form of urea), without any increase in the mean temperature of the body. There was, however, an increase in the temperature at 2, 4, and 6 o'clock, when digestion was most active. The gradual loss of weight of the body was very striking.

The phosphoric acid, chlorine, and free acidity in the urine.

Days.	Phosphoric acid.	Chlorine.	Free acidity calculated as crystallized oxalic acid.
	grammes.	grammes.	grammes.
1st day	1·886	7·295	
2nd day	2·081	8·571	
3rd day	2·338	9·045	
4th day	2·348	9·242	1·865
5th day	2·327	7·011	1·415
6th day	2·460	8·307	2·192
7th day	2·328	6·134	1·890
8th day	2·582	6·688	1·891
9th day	2·340	7·799	2·538
10th day.....	2·272	7·072	1·892
11th day.....	2·132	6·467	1·828
12th day.....	2 234	6·399	1·885
13th day.....	2·352	5·524	1·756
14th day.....	2·450	6·658	1·940
15th day.....	2·333	5·403	1·486
16th day.....	2·442	5·793	2·709
17th day.....	2·577	5·999	2·972
18th day.....	2·132	6·498	2·948
19th day.....	1·942	7·045	2·182
20th day.....	1·881	6·235	2·503
21st day	2·678	6·276	2·784
22nd day	2·405	7·422	2·457
23rd day	2·265	6·543	2·782
24th day.....	2·453	7·494	2·469
25th day.....	2·138	7·713	2·013
26th day.....	2·286	10·763	1·968
27th day.....	2·798	7·074	3·339
28th day.....	3·040	7·025	2·745
29th day.....	2·722	6·170	2·308
30th day.....	1·182	5·286	1·489

The mean quantities are as follows:—

	Phosphoric acid.	Chlorine.	Free acidity.
First period (before wine).....	2·296	7·708	1·955
Second period (during wine)	2·247	6·202	2·221
Third period (after wine).....	2·396	7·176	2·435

Red Bordeaux wine, in quantities of 10 and 20 ounces per diem, did not

affect the excretion of phosphoric acid. The effect on the chlorine is uncertain, as that ingredient has such a wide range of variation. It is, however, interesting to note that the mean daily excretion of the whole thirty days is almost precisely the same as the mean daily excretion of the twenty-five days in the previous series (viz. 7·028 grammes as against 6·915 grammes), and this proves the equality of the diet.

The acidity of the urine was increased during the wine-period, and this continued afterwards. It may be observed that the mean free acidity of the former experiments was almost precisely the same as in these experiments during the water-period (viz. 1·974 as against 1·955 gramme), and was very nearly the same in the alcoholic as in the wine-period (viz. 2·342 as against 2·221).

It seems fair to conclude that the free acidity was really increased, and that the increase continued subsequently.

5. The Alvine Discharges.

Weight of Stools.

Days.	Ounces.	Grammes.	Days.	Ounces.	Grammes.	Days.	Ounces.	Grammes.
1.	4·5		11.	4·25		21.	3·3	
2.	6		12.			22.		
3.			13.	5·75		23.	8·33	
4.	7·25		14.	8·1		24.		
5.	4		15.	4		25.	6·75	
6.	4·25		16.	4		26.	4·5	
7.	3·75		17.			27.	4·75	
8.			18.	7·25		28.	3·25	
9.	3·75		19.	3·75		29.		
10.	7·97		20.	3·5		30.	7	
Means	4·147	117·56		4·060	115·1		3·788	107·4

The nitrogen was determined twice, viz. on the 10th day (last day before wine), and on the 19th day (last day but one of wine). Unfortunately there had been some constipation before the 10th day, and the stool was unusually copious and less watery; it represented, in fact, some accumulation, and therefore the nitrogen ought to be credited in part to the previous days.

The following Table gives the results :—

Days.	Weight of stool.		Percentage.			Amount of nitrogen in 24 hours.
			Solids.	Water.	Nitrogen.	
	ounces.	grammes.				grammes.
10th day (water drinking)	7·97	226·0	32·405	67·595	1·294	2·925
19th day (wine drinking)	3·75	106·3	21·820	78·180	1·207	1·283

Looking to the mean weight of all the stools, to the particular circumstances of the 10th day's stool, and the very nearly equal percentage of nitrogen on the 10th and 19th days, it may be concluded that the wine did not affect the intestinal discharges either as regards quantity or nitrogen.

6. The Elimination of Alcohol.

As in the former series, the numerous experiments we had to perform prevented us from thoroughly investigating this difficult problem. We tested the appearance of alcohol in the excreta by the bichromate-of-potassium test as before. The general results were as follows :—

Elimination by the breath.

In the first period the bichromate test was not tried on the first day; it was very slightly changed in colour on the 2nd, 3rd, and 4th days, when the breath was blown through the test for 15 minutes about 2 o'clock. On the remaining 5th, 6th, 7th, 8th, 9th, and 10th days, no change was produced. On the 1st day of wine after dinner, the colour became green in eight minutes, on the 2nd day in six minutes, and subsequently a little sooner. On the 16th and subsequent days (when the wine was doubled) the change was much greater. In the evening, except in one or two cases, no change was produced. On the 21st day (1st day after wine) and subsequent days there was no alteration.

The breath was condensed by a freezing-mixture on the 9th day about 4 o'clock; about $\frac{1}{2}$ cub. centim. was collected; it was tested for alcohol by the Iodoform test, but none was found; it was unfortunately not examined by the bichromate test. On the 20th day (20 ounces of wine) the breath was again condensed; it gave an immediate marked green reaction with the bichromate test. On the 22nd day (the 2nd after the wine) it was again condensed, and gave still an immediate reaction, though not so marked as on the 20th day; so that two days after the wine was left off, some was passing off by the lungs, though it was not detected by merely breathing through the test.

On the 25th and 28th days, when the breath was again condensed, no effect was produced on the bichromate test.

Elimination by the skin.

In the former series of experiments, when the perspiration was obtained by putting the arm in an hermetically sealed glass jar, no effect was produced in the bichromate test by the sweat before alcohol had been taken.

But on this occasion, when 12 cub. centims. of perspiration were collected in four hours on the 5th day, the bichromate test was at once made green. No alcohol was detected by the Iodoform test, but we are not certain if this can be relied upon. This was on the 17th May, and no alcoholic liquid had been taken since the 25th April.

It seemed improbable that alcohol, taken so long before, could be still passing off; and if not, then the perspiration may at times contain some non-alcoholic substance capable of reducing the bichromate.

The perspiration of the arm was condensed on the 10th day (before wine), on the 19th day (during wine), and on the 26th, 28th, and 30th days (after wine). In all cases an extremely marked green reaction was at once given.

We conclude, therefore, that fresh experiments are necessary with regard to the correctness of the bichromate test, when applied to the condensed perspiration.

Elimination by the kidneys.

The examination was conducted in the same way as on the former occasion, the urine being first distilled, the distillate tested with the bichromate test, and if no reaction was given redistilled.

The following Table gives the results:—

Days.	Reaction with bichromate.	
	1st distillate.	2nd distillate.
6th day (water).....	A very slight and scarcely perceptible change.	A very slight change, scarcely to be affirmed *.
15th day (wine, 10 oz.) ...	No change.	No change*.
16th day (wine, 20 oz.) ...	No change.	No change*.
18th day (wine, 20 oz.) ...	No change.	Slight.
20th day (wine, 20 oz.) ...	Slight.	Marked.
22nd day (water)	None.	None.
27th day (water)	None.	None.

We conclude from this Table that when 10 ounces of wine (containing 1·1 ounce of absolute alcohol) were taken, no alcohol passed into the urine. On the 16th day, when 20 ounces (=2·2 ounces of absolute alcohol) were taken, none was found in the urine; the next day no examination was made, but on the 18th day alcohol was detected, and two days later the reaction was marked. Two days after the wine was left off no alcohol was found.

Therefore, when this man took 2 ounces of absolute alcohol day after day, some of it was eliminated by the urine. When he took only 1 ounce, none was eliminated during the space of five days. If, as has been surmised by Dr. Anstie, the appearance of alcohol in the urine indicates that there is an excess in the body, it seems clear that this man cannot take much more than 1 ounce without the urine giving evidence of it, and thereby proving excess. It soon disappeared from the urine, certainly on the 2nd day (the first day's urine was not examined), whereas, on the former occasion, when a much larger quantity had been taken, it could be detected five days after it had been discontinued.

* Tested also with the Iodoform test. No reaction.

Elimination by the bowels.

No experiments were made.

General Conclusions.

1. The general results of these experiments are in all respects identical with the experiments on alcohol and brandy, that is to say, there was a marked effect on the heart, coinciding tolerably well in amount with the effect produced by pure alcohol in the former experiments; there was no unequivocal alteration of temperature in the axilla or rectum, no alteration in the elimination of nitrogen, for the increase in the last period cannot be credited to the direct effect of the wine; no alteration in the phosphoric acid of the urine; some augmentation of the free acidity of the urine; no alteration of the alvine discharges. In other words, claret-wine in the above quantities cannot so far be distinguished in its effect from pure alcohol. Its most marked effect, the increase of the heart's action, must be ascribed to the alcohol, in great measure, though the ethers may play some slight part.

But it would be going too far to assert that the dietetic effects of red Bordeaux wine and of dilute alcohol are identical. The difference between them must probably be sought in their effects on primary digestion and assimilation, delicate and subtle influences which experiments like those recorded in the paper do not touch. The influence of the sugar, of the salts, and of the acidity must also be appreciated by other methods. The man himself affirmed that the wine agreed with him better than the alcohol or brandy, but the large quantity he took of these last fluids vitiates the comparison.

These experiments on wine enabled us to define somewhat better than the previous trials what might be considered moderation for this man. The 10 ounces of wine, containing about 1 fluid ounce of pure alcohol, did not cause the least unpleasant feeling of heat or flushing. The 20 ounces (containing almost 2 fluid ounces of alcohol) were manifestly too much. He felt hot and uncomfortable, was flushed, the face was somewhat congested, and he was a little drowsy. Moreover, as already mentioned, alcohol then began to appear in the urine. Therefore he ought certainly not to take much more than 1 fluid ounce of absolute alcohol in 24 hours.

With regard to the propriety of this healthy man taking any alcohol, we have no hesitation in saying he would be better without it. His heart naturally acts quickly and strongly enough; alcohol increases its action too much, and might lead on to alteration in its condition, or to injury of vessels, if any degeneration were to take place in them. This man had gone through the Abyssinian campaign, and stated that when the force was without rum, owing to deficiency of transport beyond Antalo, he had in no way felt the want of the stimulant, though some of his comrades did. This seems to confirm our opinion, that alcohol for him is not a necessity, and indeed is not desirable.

"On the Mathematical Theory of Combined Streams." By W. J. Macquorn Rankine, C.E., LL.D., F.R.SS. Lond. and Edin. Received Sept. 10, 1870.

1. *Object of this Investigation.*—The principles of the action of combined streams were to a certain extent investigated by Venturi, and stated in his essay 'Sur la Communication latérale du Mouvement dans les Fluides' (Paris, 1798). The principle of the conservation of momentum, so far as I know, was first explicitly applied to combined streams by Mr. William Froude, F.R.S., in a paper on Giffard's Injector, read to the British Association at Oxford, in 1860, and published in the Transactions of the Sections, p. 211. Various other authors have treated the same problem by different methods, based virtually on the same principle. A very complete and precise investigation of the theory of combined streams, in every case in which two streams only are combined, is contained in Professor Zeuner's treatise 'Das Locomotivenblasrohr" (Zürich, 1863), The theoretical conclusions are tested by comparison with experiment, and applied to practical questions, especially those relating to the apparatus from which the treatise takes its name. The object of the present investigation is to apply similar principles to the combination of any number of streams; and the demonstration of the fundamental dynamic equation differs from that given by Zeuner in method, though not in principle, being effected at one operation by the direct application of the principle of the equality of impulse and momentum, instead of by the consideration of the loss of energy that takes place during the combination of the streams.

2. *Terms and Notation used, and Suppositions made.*—The several streams which are combined will be called before their junction, the *component streams*; the stream formed by their combination will be called the *resultant stream*. The passages through which the component and resultant streams flow will be called respectively the *supply-tubes* and the *discharge-tube*. The combination of the streams will be supposed to take place in a short cylindrical chamber, with its axis parallel to the direction of flow, which will be called the *junction-chamber*.

At one end of the junction-chamber are the outlets of the supply-tubes, which will be called the *nozzles*; at the other end, the inlet of the discharge-tube, which will be called the *throat*. It will be supposed, further, that the supply-tubes are so formed as to direct the component streams at the nozzles, so that they shall all flow sensibly parallel to each other and to the resultant stream. The principal symbols used are as follows: for any one of the component streams:—

a, area of nozzle;

v, velocity of flow at nozzle;

s_0, bulkiness, or reciprocal of density at nozzle.

The several component streams may be distinguished from each other, when required, by suffixes; as 1, 2, 3, &c.